Over-investment and Financial Crisis: The Case of Korea

Jaerang Lee and Kar-yiu Wong
University of Washington

July 25, 2003
(Version 1.0)

Abstract

This paper examines the roles of over-investment, over-production, and over-borrowing of firms in the financial crisis in Korea in 1997. Herding or group effect has been used to explain how over-investment may occur even when all firms are rational. The paper also tests where the investment of firms in Korea before and after the financial crisis showed group effect.

1 Introduction

The outbreak of the financial crisis that shook many Asian economies was usually marked with the sharp devaluation of the Thai baht in July, 1997. Since then, many other economies in Asia were hit by similar shocks. In November, Korea became the new victim of the waves of financial troubles.

The occurrance of the financial crisis in Korea was a big surprise to many people and the local government. Korea, one of the four newly industrialized economies in Asia and a member of the Organization for Economic Cooperation and Development (OECD), has been growing quite steadily with sound macroeconomic fundamentals, with GDP growing at an average of 8 percent in 1994-1997.[1] In fact, most Asian economies that were hit by the financial shock had generally sound macroeconomic fundamentals before the crisis.

The experience of these Asian economies suggests that crisis models that emphasize macroeconomic misalignment and destablizing government macroeconomic policies are not suitable to explain the Asian crisis. For example, Krugman (1979) links continuing government deficits to depletion of foreign reserves and financial crisis.[2] Kaminsky (1999) also argues that financial crises tend to occur in countries with weak macroeconomic fundamentals. The conditions that those models emphasize for the emergency of a financial crisis do not seem to have exist in these economies.

The difficulty of linking the recent financial crisis to the macroeconomic side of the economies suggests that the microeconomic side of the economies could play a bigger role in creating an economic environment in which the economies are more vulnerable to financial shocks. The long periods of high growth rates in these economies before the crisis and the apparent good economic conditions these economies were facing lend weight to this approach. As Radelet and Sachs (1998) argue, "continuing, and in some cases increasing, high economic growth" itself is one reason why the Asian crisis was not predicted. Other crisis theories based on microeconomic situation includes McKinnon and Pill (1996) and Chari and Keho (2001). McKinnon and Pill

[1] The assessment of international observers and analysts about the Korean economy before the crisis was generally very favorable. For example, the IMF released an Executive Board Discussion Report in November 1996, which is quite positive about the development of the Korea economy. The report states that "Directors welcomed Korea's continued impressive macroeconomic performance: growth had decelerated from the unsustainably rapid pace of the previous two years, [and] inflation had remained subdued.."

[2] See, for example, Saxena and Wong (2000) for a recent survey of some of these models.

(1996) emphasize over borrowing and over optimism that exist as a result of moral hazard in the local banking system, while Chari and Keho (2001) blame international investors for their herding behavior in syndicated loans.

This paper attempts to examine some the causes of the Korean crisis in 1997 by focusing on the microeconomic side of the economy before the crisis. Its purpose is two-fold. First, it provides a simple framework to explain how the splendid economic performance of the economy two or three decades before the crisis could have the unintentional, side effect of bringing the economy to a crisis. Specifically, this paper argues that long periods of good times for the firms in the sixties to nineties, during which the Korean economy experienced impressive growth rates, had led to over-optimism of firms, which choose to produce and invest significantly. Over-production and over-investment were also in part caused by herding behavior of firms.[3] To finance the increase in production, many firms relied on loans from local banks and financial intermediaries, which in turn borrow from abroad. When firms face good times, they can easily sell their products, repay the loans, and likely borrow more to support further increase in production. The work we establish is a simple extension of the one in Wong (2000), but we focus on the production behavior of domestic firms.[4] Recently, the roles of herd behavior of economic agents in financial crisis had received much attention and had been used as a way of explaining the phenomenon of bubbles. Shiller (1990) shows herding by investors in financial markets increases the volatility resulting in the crash of US capital market in 1987. Kim and Wei (1999) find that non-resident investors show increased herding behavior in Korean stock market after the outbreak of Korean crisis. Choe, Kho, and Stulz (1999) show that foreign investors' significant herding prior to the Korean Crisis.

The second purpose of this paper is to test whether firms showed over-investment before the crisis, and whether the investment decision of firms had been influenced by the investment levels of other firms, i.e., whether there were group effect.[5] We use firm-level data before and after the crisis

[3]It is the tendency that economic agents mimic each others' decision or choice. A earlier theoretic work on herding includes Scharfstein and Stein (1990), Benerjeee (1992), and Froot, Scharfstein, and Stein (1992). A notable survey on herding behavior literature are researches by Devenow and Welch (1996), and by Bikhchandani and Sharma (2001).

[4]Wong (2001) also applies herding behavior to provide a model of bubbles in the Thailand housing market. He provides an explanation of how local housing firms can become too optimistic and over-production and over-borrowing, thereby raising the vulnerability of the economy.

[5]See Saxena and Wong (2002) for investigating the relationship between economic

to investigate the presence of group effect before and after the crisis. The investment specification of firms used in the present paper is extension of that in Fazzari, Hubbard, and Petersen (1988). We add the interactions and group effect in a firm's investment decision.[6]

The paper is organized as follows: Section 2 establishes a theoretical model of herding, over-investment, over-production, over-borrowing, and financial crisis. Section 3 describes the data, while section 4 specifies empirical specification. Section 5 explains the estimation results, and section 6 concludes.

2 Growth, Herding, Over-Investment, and Financial Crisis

This section provides a theoretical model, which an extension of Wong (2000), to explain why over-investment in an economy may occur in a growing economy, even if all economic agents are rational, and how it could lead a financial crisis.[7]

Consider a one-product, two-period, three-country model. The countries are labeled home (Korea), foreign, and the rest of the world (ROW). The product, labeled X, can be produced by $n \geq 1$ firms in home and one single firm in foreign, but production takes two periods. In the first period, home firm i, $i = 1, ..., n$, has to hire l_i workers (and possibly other factors) to carry out the production process. At the end of the period, a quantity of the product x_i is produced, where the

$$l_i = \alpha + \beta x_i \tag{1}$$

growth, over-investment, and financial crisis using a different approach and the data of different countries.

[6]There have been some other papers with alternative approach to estimating group effect. For example, Gompers (1995) estimates the venture capital investment with industry effect. He regresses the venture capital investment on industry tangible assets, industry market value of equity to book value ratio, industry R&D expenses in addition to other firm specific variables. Athey and Reeser (2000) estimate investment function of firms in India. They add a time variant unobservable factor to the specification in Fazzari, Hubbard, and Petersen (1988). Carpenter, Fazzari and Petersen (1994) add time dummies for industry to estimate an inventory investment function to see time and seasonal effect.

[7]For an alternative model to analyze bubbles in the Thai housing market before the financial crisis in the country in 1997, see Wong (2001).

where α, $\beta > 0$. Denote the wage rate in the first period by w, meaning that the firm has to pay wl_i to the workers. This amount is borrowed from a local financial intermediary, which in turn borrows from abroad. If the market interest rate is r, the firm has to pay back $wl_i(1+r)$ in period 2. There is also a fixed cost equal to f to be paid in the second period. Note that all home firms have identical technologies and are facing the same market conditions. So in equilibrium they will choose the same output level. The foreign firm can be described in a similar way, but for simplicity and for the purpose of this paper, it is not described explicitly. Firms compete in a Cournot way.

The demand for product X exists in ROW but not in home or foreign. There is a certain degree of uncertainty faced by the firms: In period 1 when they have to choose the amount of labor to employ, the demand in period 2 is unknown. Suppose that there are only two states of nature in period 2, good and bad, and the market price p depends on the state. If the good state occurs, the demand is denoted by $p = p^g(q)$ and if the bad state occurs, the demand is $p = p^b(q)$, where $p^g(q) > p^b(q)$ for all demand $q > 0$. We further assume that the marginal revenue is higher than in a good state than in a bad state for all relevant outputs. The demand function in each state is decreasing and not too convex to the origin, i. e., $p^{j\prime}(q) < 0$ and $p^{j\prime\prime}(q) < \sigma$, where a prime denotes a derivative and σ is a positive number sufficiently small. This assumption guarantees that the marginal revenue is decreasing with quantity. The market equilibrium condition is

$$q = x^* + \sum_{i=1}^{n} x_i, \tag{2}$$

where x^* is the output of the foreign firm.

Even though the demand function is each state is known to all firms, the probability of each state is not. Suppose that firm i perceives that the probability of good state is ρ_i. It chooses the employment level (or output level) to maximize the future value of profit:

$$\begin{aligned} \max_{x_i} \tilde{\pi}_i &= [\rho p^g(q)x_i + (1-\rho)p^b(q)x_i] - wl_i(1+r) - f \\ &= \tilde{p}(q)x_i - wl_i(1+r) - f, \end{aligned} \tag{3}$$

subject to (1) and (2), where $\tilde{p}_i(q) \equiv \rho_i p^g(q) + (1-\rho_i)p^b(q)$ is the firm's expected price.

Taking the outputs of other firms as given, the first order condition for a maximum profit of firm i, assuming an interior solution, is,

$$\frac{\partial \tilde{\pi}_i}{\partial x_i} = \tilde{p}_i' x_i + \tilde{p}_i - w\beta(1+r) = 0, \tag{4}$$

where $\tilde{p}_i' = \rho_i p^{g\prime}(q) + (1-\rho_i)p^{b\prime}(q)$. Condition (4) is the firm's reaction function. After deriving similar conditions for other firms, the Nash equiliibrium can be determined in a straightforward way. Since the firm chooses its output based on the expected market price, which is a weighted average of the good-state price and the bad-state price. This means that if the good (bad) state occurs, the firm's profit is higher (lower) than the expected profit.

Suppose that, for whatever reason, home firm i is more optimistic about the future, i.e., there is a rise in ρ_i. Differentiate (4), holding other firms' outputs constant, to yield

$$\frac{d\tilde{x}_i}{d\rho_i} = -\frac{MR^g - MR^b}{\rho_i[p^{g\prime\prime}\tilde{x}_i + 2p^{g\prime}] + (1-\rho_i)[p^{b\prime\prime}\tilde{x}_i + 2p^{b\prime}]} > 0. \tag{5}$$

Condition (5) states that a firm increases its output as it becomes more optimistic.

The present model can now be applied to examine the case of Korea. Suppose that initially all home firms are identical and have identical expectation of the future, i.e., $\rho_i = \bar{\rho}$ for all i. As a result, they will choose to produce the same output at the initial Nash equilibrium.

In the period from the sixties to mid-nineties, the Korean economy and the surrounding economies were growing with high rates. These spectacular growth rates were the results of a series of internal and external factors, but they have contributed to a general rise in the optimism of firms. Two reasons can be offered to explain this rise in optimism. First, the growth of these economies had led to high demand for the outputs of home firms. In terms of the present model, that means that firms have been experiencing good states most of the time. Since the true probability of a good state is unknown, and if firms make estimation of the probability based on past history, they would revise the estimated probability over time. Second, if there were some firms that were more aggressive, i.e., with higher perceived probability of the good state than others', they would produce more. When good states occurred, they were rewarded with higher profits than what other firms received. Observing the success of these aggressive firms, other firms

quickly took the same step and became more aggressive. Taking actions similar to the observed actions of others is often termed herding behavior in the literature. Herding is not necessarily irrational. For managers of firms, they usually face pressure from shareholders to make profits. In most cases, these managers can make losses more acceptable to the shareholders and owners if other firms in the same industry are making comparable losses, but will be in big trouble if their firms make losses while others are not. On the other hand, even if they are able to make profits, they would have a hard time to explain to the shareholders without appearing to be too dumb if the profits they make are smaller than what some other firms make. As a result, they usually are willing to be aggressive if there are some other firms acting aggressively, even if that is not what they would do based solely on their estimation.

To see the effects of an increase in optimism, let's suppose that all home firms and the foreign firm initially have identical perceived probability of the good state. Then for some reasons all home firms become more optimistic while the foreign firm does not. From now on, we drop the subindex representing a home firm since in equilibrium they make the same decision. Differentiating (4) for a home firm, we get,

$$[n\tilde{p}''x + (n+1)\tilde{p}']dx + [\tilde{p}''x + \tilde{p}']dx^* + (MR^g - MR^b)d\rho = 0. \tag{6}$$

The first-order condition of a foreign firm can be obtained in a similar way, and by differentiating its first-order condition, we have

$$n(\tilde{p}''x^* + \tilde{p}')dx + (\tilde{p}''x^* + 2\tilde{p}')dx^* = 0. \tag{7}$$

Solving (6) and (7) together, we get the effect of ρ on output as,

$$\frac{dx}{d\rho} = -\frac{(MR^g - MR^b)(\tilde{p}''x^* + 2\tilde{p}')}{\tilde{D}} > 0 \tag{8}$$

$$\frac{dx^*}{d\rho} = \frac{n(MR^g - MR^b)(\tilde{p}''x^* + \tilde{p}')}{\tilde{D}} < 0, \tag{9}$$

where $\tilde{D} = \tilde{p}'\tilde{p}''(nx + x^*) + (n+2)(\tilde{p}')^2 > 0$. Conditions (8) and (9) are combined together to give:

$$n\frac{dx}{d\rho} + \frac{dx^*}{d\rho} = -\frac{n\tilde{p}'(MR^g - MR^b)}{\tilde{D}} > 0. \tag{10}$$

Condition (10) implies that there is a drop in the equilibrium price of the product in the ROW.

We now determine the effect of this rising optimism on the profit of home firm i when good state is realized.

$$\frac{d\pi_i^g}{d\rho} = \frac{\partial \pi_i^g}{\partial x_i}\frac{dx_i}{d\rho} + \sum_{k \neq i} \frac{\partial \pi_i^g}{\partial x_k}\frac{dx_k}{d\rho} + \frac{\partial \pi_i^g}{\partial x^*}\frac{dx^*}{d\rho}. \tag{11}$$

The three terms on the right-hand side of (11) represent the direct effect, the cross effects from other home firms, and the foreign-firm effect, respectively. The appendix shows that the direct and foreign-firm effects are positive while the cross effect is negative. The cross effect depends on the number of home firms, and is zero if there is only one home firm. As long as the number of home firms is small, the direct and foreign-firm effects will outweigh the cross effect, meaning that an increase in home firms' optimism will lead to a rise of their profits in a good state.

If, however, the bad state occurs, then the effect on the home firm's profit is

$$\frac{d\pi_i^b}{d\rho} = \frac{\partial \pi_i^b}{\partial x_i}\frac{dx_i}{d\rho} + \sum_{k \neq i} \frac{\partial \pi_i^b}{\partial x_k}\frac{dx_k}{d\rho} + \frac{\partial \pi_i^b}{\partial x^*}\frac{dx^*}{d\rho}. \tag{12}$$

The three terms on the right-hand side of (12) represent the direct effect, cross effect from other home firms, and the foreign-firm effect. As shown in the appendix, the direct and cross effects are negative while the foreign-firm effect is positive. So as long as the foreign-firm effect is not too large, an increase in the home firms' optimism will lower their profit in a bad state.

We now try to establish the links between economic growth, herding, over-investment, and financial crisis. Many Asian economies experienced high growth rates in the period from the sixties to mid-nineties. Such impressive growth not only raised the national income levels of these economies, but also the general optimism of firms and consumers. Such rise in optimism caused sufficient increase in production and investment of the firms, and to finance such increase in production and investment, firms borrow more from financial intermediaries, which in turn borrow from abroad. As long as the economies and the ROW were growing, the firms saw that the profits were soaring. This had two implications. First, they did not have any problems in repaying the loans. Second, herding would have existed, with less aggressive firms becoming more aggressive. This further raised the general optimism level of the economies.

During good times, everything was fine, with firms generally making positive profits, being able to repay their loans, and then getting new loans. However, the rise in optimism and production had its own problem: the profits of the home firms in a bad state could be very low, or negative. As a matter of fact, the longer the economies experiencing good times, the more optimistic the firms may become, the higher production and investment they want to make, the more money the economies could borrow from abroad, but the more losses these firms may get should a bad state occurs. When the losses some of the firms get are too high, they will not be able to repay the loans and could go bankrupt. If sufficient number of firms were forced into bankruptcy within a short period of time, banks will not be able to repay foreign loans.

The theory above provides one way of explaining the occurance of a financial crisis. Obviously many other factors could have contributed to the financial crises experienced by many Asian economies. However, it does offer a way of capturing some of the important features of the financial crises in Asia: high and long periods of growth before the crisis, significant amounts of foreign debts, high production and investment levels of many firms, and sound fundamentals before the crisis.

3 Firm-Level Data

The data set used in the present paper is taken from National Information and Credit Evaluation, Inc. (NICE), Seoul, Republic of Korea. As a privately owned credit evaluation company, it compiles the financial data and profiles of Korean firms which are mandated by law to publish and announce their annual financial statements. The data set spans from 1990 to 2000, which includes the starting year of the crisis. On November 18, 1997, the Bank of Korea, the central bank of the country, officially gave up defending the Korean Won. On November 21, 1997, the Korean government sought bail-out loan from the International Monetary Fund.

We use the data for 466 firms which are listed on Korea Stock Exchange and have reported its financial statement continuously over the sample period of 1990 to 2000. They are mostly the manufacturing firms. Financial service firms, mining companies, construction firms, other service firms, and telecommunications firms are excluded, as these firms' accounting practices are different from those of the firms included in the present study.

The paper uses the industry to which each firm belongs the reference group of the firms. In other words, firms are assumed to mimic previous and observed decisions of firms in the same reference group. Industry is classified according to two-digit Korean Standard Industrial Classification.[8] The choice of reference group needs to satisfy the following criteria. First, it should be exogenous. By nature, firm cannot easily switch from one industry to another. During the period of 1990 to 2000, there was no Korean firm, which switched its area of belonging from one industry to the other. Second, to examine if there is a link between a firm's behavior and that of group, one needs to find a group of agents that acts similarly. Such a group is more likely to act similarly if its members are sufficiently homogeneous. We may assume that a car manufacturer will more likely follow other car manufacturer's past behavior than to that of, say, firms producing chemicals.

Table 1 provides summary statistics of basic data for all sample firms over the period 1990 to 2000. In the study, all variables are divided by the total fixed asset, K. The firm level data shows that up until the Crisis, there was no contraction of the investment (I/K). Korean firms average investment level (I/K) had consistently increased from 1990 to the crisis period in 1997.

4 Estimation

The work uses the firms' investment data to see if they had tendency to behave similarly in capital investment, possibly induced by increased optimism. Individual firm's investment is regressed on the mean value of industry's past investment, and the individual firm specific factors. A basic dynamic linear specification of the investment function with group effect is estimated as

$$\begin{aligned}(I/K)_{it} &= \alpha + \beta_1(\overline{I/K})_{-ig}^{t-1} + \\ &\quad + \gamma_1 ROR1_{it} + \gamma_2(CF/K)_{it} + \gamma_3(S/K)_{it} \\ &\quad + \gamma_4(S/K)_{it-1} + \gamma_5(S/K)_{it-2} + \gamma_6(LQ/K)_{it} \\ &\quad + \varepsilon_{it}.\end{aligned} \tag{13}$$

I_{it} is gross investment for firm i in year t. K_{it} is total fixed asset. Every variable is divided by the total fixed asset K_{it} to normalize. $\overline{(I/K)}_{-ig}^{t-1}$ is the

[8] Firms are classified into 14 industries, which are fishery, food, textiles, cloth, foot ware, pulp, chemicals, medication, ceramics, metals, machinery, computers, cars including other transportation, and furniture.

Table 1: Summary Statistics for Firm Level Data

Variables	Number of Observations	Mean	Standard Deviation	Min.	Max.
(In billion Korean Won)					
Investment(I)	5126	79.39577	340.1773	.03088	8444.217
Fixed Asset(K)	5126	262.4039	1757.136	.801194	58255.11
Net Profit(ROR)	5126	3.456597	181.7838	-6649.557	6014.53
Cash Flow in a Year(CF)	5126	43.93587	309.0784	-1031.032	9323.901
Total Sales(S)	5126	373.486	1375.644	.0965	34283.75
Liquid Asset(LQ)	5126	170.4076	473.9016	.935725	7781.313
(I/K)	5126	.5564885	.6661783	.0021696	9.991061
Average in 1990	466	.4337444	.4498929	.0047085	5.527928
1991	466	.4650771	.4769686	.0053524	6.641049
1992	466	.4999145	.4994258	.0045869	6.739108
1993	466	.5006424	.5621663	.0021696	7.796818
1994	466	.5157428	.4856172	.0093163	6.191966
1995	466	.5764134	.5635421	.0177305	6.866326
1996	466	.6439419	.6238129	.0086788	6.168007
1997	466	.6978697	.8045107	.0060074	8.876321
1998	466	.5631269	.7339506	.0084314	9.11556
1999	466	.6707493	1.001933	.0082689	9.991061
2000	466	.5541514	.8311911	.0025595	8.276673
ROR1=(ROR/K)	5126	.0283057	1.140329	-17.10769	64.26292
(CF/K)	5126	.2130031	.4130762	-8.344759	2.793535
(S/K)	5126	3.336861	3.094999	.010658	56.83672
(LQ/K)	5126	1.958215	2.070252	.0309075	31.05304

lagged average of (I/K) of the reference group g, excluding firm i itself. The reference group g is the industry which firm i belongs to at year t. This shows the group characteristics and captures firms tendency to imitating others in investment decision. By taking the mean of the reference group, β_1 captures the how much of the investment is harmonized with that of the rest of the members in the same reference group.[9] The work uses one period ahead mean values of the reference group as identifier for the following reasons. First, it is reasonable to assume that firms may not observe or it may be too costly to observe others' current capital investment decision. Unlike the financial investment, capital investment takes more time to settle down. It is difficult for a firm to observe other firms capital investment decision since firm are not mandated to report its statement until the end of each fiscal year. In Korea, each listed firm is mandated to publish its annual financial report after each fiscal year and it is available to everyone in the economy with almost no cost. Group characteristic is assumed to be observable one period later. This assumption is consistent with that of the herd theory, in which each economic agent of an economy is assumed to follow previous, observed behavior of other members. Note that the group effect cannot be identified when we use current period mean value. It is so called 'reflection problem' (Manski, 1993, 2000).

The remaining terms capture the conventional investment function of a firm, following the approach in Fazzari, Hubbard, and Petersen (1988). $ROR1_{it}$ is the ratio of firm i's net profit to total fixed asset (K_{it}), as a measure of profitability, or returns. This term captures the effect from the classical investment theory's point of view. CF_{it} is the cash flow of firm i at year t. If the capital market is perfect, a firm's investment decision is independent of its internal financial conditions, for example, cash flow. If the capital market is imperfect, a firm's investment is more likely to be sensitive to readily available internal fund. This is because the internal fund and external fund are not perfect substitutes in an imperfect capital market.

S_{it} is total sales of firm i at time t. Some of the empirical investment models are based on the acceleration principle. The principle links the demand for capital investments to the level or changes in a firms output or sales.

[9] Ashia and Doi (2001) have a similar model specification to examine the group effect in macroeconomic forecasting among economists. They regress individual data on the current group mean of dependent variable excluding the individual itself.

Table 2: Estimation with Industry as Reference Group: LS and 2SLS

	Dependent Variable: $(I/K)_{it}$					
	LS				2SLS with lag	
	Coefficients	t-value	Coefficients	t-value	Coefficients	t-value
$(\overline{I/K})_{-ig}^{t-1}$	-	-	.2050883	7.43	.2622547	7.80
$(ROR1)_{it}$	-.0277769	-3.93	-.0271192	-3.86	-.0269359	-3.83
$(CF/K)_{it}$	-.1155997	-5.26	-.1017575	-4.64	-.0978992	-4.45
$(S/K)_{it}$	.0440532	6.70	.0422424	6.46	.0417377	6.38
$(S/K)_{it-1}$	-.007209	-1.04	-.0083846	-1.22	-.0087123	-1.26
$(S/K)_{it-2}$	.0137479	2.47	.0136567	2.47	.0136313	2.46
$(LQ/K)_{it}$	.1422631	19.95	.1408661	19.87	.1404767	19.80
intercept	.155258	11.61	.0405066	1.99	.0085207	0.37

LQ_{it} is total liquid asset of firm i at time t. If the capital market is imperfect, the stock measure of liquid internal fund may have an effect on the investment decision of a firm that faces high external funding cost. The liquid asset stock may play as a cushion to the lack of cash flows. It may provide necessary collateral when a firm needs to obtain new external fund.

5 Estimation Results

5.1 Estimation with industry as reference group

The estimates of the linear model are reported in Table 2. The first column reports the dependent variables. Left side of the half is the result of Least Squared regression. The model explains a portion of the changes in firm's investment as a result of following other firm's investment decision made one year before. Coefficient of $(\overline{I/K})_{-ig}^{t-1}$ shows this group effect. It turns out to be positive (0.205) and significant. Firms have tendency to increase investment after observing the other firms in the same industry increase their investment.

Firm specific characteristics are significant factors, too. In one part firms follow the others in the group, but in the other part, they make investment decision based on own information. Total sales in current period have positive

effect (0.042) on the investment as expected. Liquid assets have positive effect (0.141) on the investment as expected. The past sales are insignificant, or have lower significance compared to the other factors. The returns and cash flows have negative effect as opposed to the theory's expectation. It may indicate the time-to-build effect in new investment. Liquid asset has positive effect. It may play an important role as collateral for external borrowings.

We must be careful to interpret the least squared regression results with lagged dependent variable. There might be an unobservable error components or there might be endogeniety that is invariant over the year within groups. This might bring bias in group effect coefficient.[10] The unobservable endogeniety would also produce bias in the coefficient of exogenous variables, like that of return ($ROR1_{it}$), cash flows $(CF/K)_{it}$, sales $(S/K)_{it}$, and liquid asset $(LQ/K)_{it}$. [11]

Next, the paper tries the two stage least squared regression. The estimates of the linear model with instruments are reported at the right side in Table 2. Using two period lagged group mean as an instrument for one period lagged group mean, the paper obtains similar coefficients on group mean term and other variables. Signs of all coefficients do not change. The results shows positive and significant group effect of firms. This may assures the least squared estimation if the instrument is valid. However, it is possible that the instrument is not be a good one. If there were time invariant unobservable error component within group, two period lagged group mean would not be

Table 3: Estimation with Industry as Reference Group: First Differences

	Dependent Variable: $\Delta(I/K)_{it}$					
	LS with differences with intercept				LS with differences without intercept	
	Coefficients	t-value	Coefficients	t-value	Coefficients	t-value
$\Delta(I/K)^t_{-ig}$	-	-	.1935744	3.17	.9488909	12.45
$\Delta(ROR1)_{it}$	.0038745	0.58	.0028448	0.43	-.0017069	-0.20
$\Delta(CF/K)_{it}$	-.1275566	-4.30	-.1245284	-4.20	-.1332561	-3.48
$\Delta(S/K)_{it}$	.0638892	6.12	.063013	6.04	.0457573	3.41
$\Delta(S/K)_{it-1}$	.0500277	6.90	.048576	6.69	.0225537	2.42
$\Delta(S/K)_{it-2}$	.0614893	8.35	.0620095	8.43	.0425938	4.50
$\Delta(LQ/K)_{it}$	.024329	1.56	.0255129	1.63	.02955	1.47
intercept	.6019785	52.04	.5925516	49.67	-	-

a good instrument.[12]

Next, the work tries to estimate the model using first differences to deal with that issue. If there is time invariant unobservable component, we may difference the data overtime to get rid of it. This may reduce the bias men-

[10]To look at the effect of unobservable endogeniety, we may start with the estimation equation in general form.

$$y_{it} = a + b\overline{y}_{-igt-1} + cx_{it} + u_g + \varepsilon_{igt}.$$

In case where unobserved u_g (endogeniety or measurement error) is correlated with regressors, we have biased estimator of parameters. Specifically the bias of the estimated b is [Var(x_{it})Cov($\overline{y}_{-igt-1}$,u_g) − Cov($\overline{y}_{-igt-1}$,x_{it})Cov(x_{it},u_g)]/A. A is a positive scalar. If Cov($\overline{y}_{-igt-1}$,u_g) is positive and greater than Cov(x_{it},u_g), estimated b is going to be biased upward.

[11]The bias of the estimated c is

$$[Var(\overline{y}_{-igt-1})Cov(x_{it}, u_g) - Cov(x_{it}, \overline{y}_{-igt-1})Cov(\overline{y}_{-igt-1}, u_g)]/A.$$

If Cov($\overline{y}_{-igt-1}$,u_g) is positive and greater than Cov(x_{it},u_g), estimated c is going to be biased downward.

[12]If the unobservable endogeniety, u_g, is time invariant, variable $\overline{y}_{-igt-2}$ contains it. Variable $\overline{y}_{-igt-2}$ is then correlated with $\overline{y}_{-igt-1}$, and also with error components of the model.

tioned above.

Table 3 reports the estimation results with differenced data. The one with intercept is for time fixed effect model. It assumes that the intercept is time variant, but invariant across individual firm. The one without the intercept is for the individual firm or group fixed effect. It assumes that intercept varies across individual firm or industry, but is invariant over time. The fixed intercept could be interpreted as the reactions to the common exogenous environment as macro fundamentals, common group environment or individual firm environment.

In the difference model, the coefficient for group mean is reduced a bit as time invariant error component is removed. However, it is still positive (0.193) and significant. Without intercept in difference model, it is much exaggerated (0.949). The intercept term would represent the time trend effect or effects from common macro environment. If we assume macro environment is time invariant, or there is no time trend effect, the group effect will be exaggerated. The coefficient of the return changes from negative to positive (0.002), or relatively small negative number (-0.001), but it becomes insignificant. That of cash flow is still negative. In summary, differenced model reduces upward bias in group effect and downward bias in other effects. Difference model shows the importance of time trend, or common macro environment.

Since omitting time trend effect would over estimate the group effect, explicit time trend variable is added to the least squares regression. Table 4 shows the least squares model and two stage least squares model with time trend. As expected, time trend effect turns out to be positive (0.013) and significant. Adding trend decreases the coefficient for group mean to 0.164, but still it is significant and positive.

So far, the models are estimated under the assumption that classical assumptions for linear regression model hold. It is assumed that variance-covariance matrix of error terms is diagonal and homoscedastic.[13] However, we generally do not know the variance-covariance structure of error term of the linear regression. Since the model assume the interactions or herding between the firms, it is more likely that each firm's error components are correlated.[14] If we run ordinary least squares regression with heteroscedastic

[13] In estimating (13) with least squares, it is assumed that $\mathrm{E}(\varepsilon_{it}) = 0$ for all i, t, $\mathrm{E}(\varepsilon_{it}\varepsilon_{jt}) = 0$ for all $i \neq j$, $\mathrm{E}(\varepsilon_{it}\varepsilon_{is}) = 0$ for all $t \neq s$, and $\mathrm{E}(\varepsilon_{it}^2) = \sigma^2$ for all i, t.

[14] It is likely that $\mathrm{E}(\varepsilon_{it}\varepsilon_{jt}) \neq 0$ for all $i \neq j$.

Table 4: Estimation with Industry as Reference Group: LS and 2SLS with Trend

	Dependent Variable: $(I/K)_{it}$					
	LS				2SLS with lag	
	Coefficients	t-value	Coefficients	t-value	Coefficients	t-value
$\overline{(I/K)}_{-ig}^{t-1}$	-	-	.1639722	5.53	.2188837	5.85
$(ROR1)_{it}$	-.0269158	-3.83	-.0266925	-3.81	-.0266177	-3.80
$(CF/K)_{it}$	-.1048724	-4.77	-.0975729	-4.45	-.0951285	-4.33
$(S/K)_{it}$	.0449859	6.87	.0432105	6.62	.042616	6.52
$(S/K)_{it-1}$	-.0066954	-0.97	-.0078157	-1.13	-.0081909	-1.19
$(S/K)_{it-2}$	.0127813	2.30	.0130479	2.36	.0131372	2.38
$(LQ/K)_{it}$	.1418991	19.99	.14091	19.91	.1405788	19.85
trend	.020834	6.22	.0135167	3.76	.0110663	2.96
intercept	-41.43234	-6.20	-.0329843	-1.17	-.0462148	-1.61

error component, we will lose the efficiency of the estimates and have the risk of overestimating the significance. That may be the reason why the estimates in Table 2 have high t-values, and we may doubt the significance of the estimates of group mean coefficient in Table 2.

The work tries to use generalized method of moments estimation to deal with heteroscedasticity. Table 5 shows the result of estimation via a generalized method of moments instrumental variable estimate (GMM-IV).[15] This estimation allows for the heteroscedasticity of unknown form, and brings the efficiency of the estimates. Table 5 shows that we can see the positive effect (0.262) of imitation and it is still significant even under heteroscedasticity assumption. As we allow the heteroscedasticity, the t-values for the other estimates drops and we gain more efficiency.

The GMM-IV method is meant to highlight its ability to deal with a heteroscedastic error process and with strictly exogenous instrumental variables,

[15] A discussion of the development of estimation is given in chapter 11 of Green, W., Econometric Analysis. 4th Ed., 2000, New York, Prentice-Hall. Specifically, the estimation is done with 'IVGMM0' module in Intercooled Stata 7.0. The module is meant to deal with a heteroskedastic error process at lag 0.

Table 5: Estimation with Industry as Reference Group: GMM-IV and KR-2SLS

	Dependent Variable: $(I/K)_{it}$			
	GMM-IV		KR-2SLS	
	Coefficients	z-value	Coefficients	t-value
$(\overline{I/K})_{-ig}^{t-1}$	.2622547	5.10	.2177446	4.52
$(ROR1)_{it}$	-.0269359	-2.48	-.0168334	-2.67
$(CF/K)_{it}$	-.0978992	-1.66	-.1914225	-8.97
$(S/K)_{it}$	.0417377	1.89	.0386571	6.05
$(S/K)_{it-1}$	-.0087123	-0.49	.0064012	1.02
$(S/K)_{it-2}$	.0136313	1.04	.0051554	0.88
$(LQ/K)_{it}$	.1404767	6.43	.1274084	19.21
intercept	.0085207	0.21	.0622075	1.48

but not with predetermined ones.[16] And if there is a serial correlation in error term, the ordinary least squares estimators and estimators of differenced model will mislead researchers. Those estimators will be biased and inconsistent under serial correlation. To deal with this issue, the work uses Keane and Runkle (1992)'s two step two stage regression method. This method eliminates the effect from the general serial correlation, while preserving the use of predetermined instruments.[17]

Table 5 also shows the estimation results with Keane and Runkle's two

[16] It is possible that $\mathrm{E}(\varepsilon_{it}\varepsilon_{is}) \neq 0$for all $t \neq s$, and $\mathrm{E}(\varepsilon_{it}z_{it}) \neq 0$, where z_{it} is a predetermined instrument.

[17] Let $Y = X\beta + u$ be the panel data model with X containing lagged dependent variable, where error term u is serially correlated. There is a set of instrument Z which is not strictly exogenous. Keane and Runkle (1992)'s estimate is,

$$\begin{aligned}
\hat{\beta}_{KR} &= [X'\hat{Q}'_{TS}P_Z\hat{Q}_{TS}X]^{-1}X'\hat{Q}'_{TS}P_Z\hat{Q}'_{TS}Y \\
\text{where, } P_Z &= Z(Z'Z)^{-1}Z', \\
\hat{Q}_{TS} &= (I_N \otimes \hat{P}_{TS}), \\
\hat{P}_{TS} &= \text{Cholesky's decomposition of } \hat{\Sigma}_{TS}^{-1}, \text{ and} \\
\hat{\Sigma}_{TS}^{-1} &= \sum_{i=1}^{n} \hat{u}_i\hat{u}'_i/N.
\end{aligned}$$

step two stage least squared regression method. The coefficient for the group mean is positive (0.217) and still significant. t-values of other estimates are lower than and estimated coefficients have similar signs as those of ordinary least squared estimation in table 1.

Since the estimate of coefficient for group mean is robust with various estimation method, it may be very informative to look at how it changes over the sample period. Table 6 shows us the results with year dummies for intercept terms and group mean coefficients. With lagged mean values of investment and undifferenced data, the coefficient on group mean is most prominent and significant in the year 1997, when the Crisis broke out.

With the differenced data, year 1996 turns out to be the most prominent year in group effect. It is a year before the crisis broke out.

In summary, the results so far suggest that the Korean firms had tendency to copy other firms' capital investment decision. Firm's tendency to follow other members previous decision in the same industry help explain the increase in investment in all specifications. For the paper's purpose the fundamental finding is that this tendency is more prominent around the crisis year, 1997.[18]

5.2 Estimation with Conglomerates as Reference Group

So far, the paper implicitly assumes that firms looks back the investment behavior of other firms in the same industry. Another reference group may also be important for investment behavior. Or we may say that it is hard to know the exact reference group as prior. With this in mind, estimation with conglomerates as reference group is tried.

The Korea Fair Trade Commission defines "chaebol" as "a group of companies, more than 30 percent of whose shares are owned by some individuals or by companies controlled by those individuals."

Korea Fair Trade Commission identifies chaebols and announces each year. Chaebols consist of many subsidiaries usually owned and controlled

[18] We can see a business atmosphere in Korea in late 1990's through an example of Habo Steel and Daewoo Group. Hanbo invested $6.2 billion in 1989-1997 and Deawoo $2.0 billion till in late 1980s-1997. In part, Korean firms optimism and ambitiousness might be attributed to the government. Y.S. Kim, the President of the Republic of Korea in 1993 – 1997, declared "se-gye-wha" (globalization) as the top policy priority. It was 'the "buzzword" in Korean corporate circles' at that time. (*Asiaweek,* February 1997 and March 1997).

Table 6: Estimation with Industry as Reference Group: Dummies for Year

Dependent Variable:	$(I/K)_{it}$		$\Delta(I/K)_{it}$	
	LS		LS with Differences	
	Coefficients	t-value	Coefficients	t-value
$(\overline{I/K})_{-ig}^{t-1}$	-.0305566	-0.16	-.6534815	-0.63
1993	-.0135027	-0.05	1.425313	1.21
1994	.0004091	0.00	(dropped)	
1995	.1294438	0.51	1.09847	0.91
1996	.1558899	0.67	2.42756	2.17
1997	.5232147	2.34	1.620454	1.53
1998	.2751289	1.33	1.694177	1.60
1999	.3631679	1.76	.1257587	0.12
2000	.1461998	0.74	1.135945	1.09
$(ROR1)_{it}$	-.0293768	-4.17	.0057123	0.86
$(CF/K)_{it}$	-.0981987	-4.47	-.129109	-4.39
$(S/K)_{it}$	.0440149	6.72	.0651712	6.32
$(S/K)_{it-1}$	-.0051039	-0.73	.0509931	7.08
$(S/K)_{it-2}$	.0105419	1.90	.0576697	7.87
$(LQ/K)_{it}$	.138227	19.52	.024797	1.60
intercept	.0972999	2.13	.6771312	20.29
1992	.0092217	0.09	(dropped)	
1993	.0161553	0.16	-.1911851	-3.81
1994	-.0000408	-0.00	-.1661421	-3.59
1995	-.0089351	-0.09	-.1149038	-2.42
1996	.0354654	0.38	-.1539175	-2.90
1997	-.2006967	-2.21	-.0710385	-1.44
1998	-.1224927	-1.63	-.1551587	-3.14
1999	-.0267164	-0.37	(dropped)	
2000	(dropped)		-.1673927	-3.35

Table 7: Estimation with Conglomerates as Reference Group: LS and 2SLS

	Dependent Variable: $(I/K)_{it}$			
	LS		2SLS with lag	
	Coefficients	t-value	Coefficients	t-value
$\overline{(I/K)}_{-ig}^{t-1}$	.1130753	1.74	.2383709	2.84
$(ROR1)_{it}$	-.0272982	-3.86	-.0267677	-3.78
$(CF/K)_{it}$	-.1142273	-5.19	-.1127065	-5.12
$(S/K)_{it}$	.0441361	6.71	.0442279	6.73
$(S/K)_{it-1}$	-.0076844	-1.11	-.0082112	-1.18
$(S/K)_{it-2}$	.0137894	2.48	.0138354	2.48
$(LQ/K)_{it}$	.1419841	19.91	.1416749	19.85
intercept	.0922117	2.39	.0223518	0.46

by a single family or by companies under a family's control. This study distinguishes top 100 chaebols from the non-chaebol firms. Then chaebol firms are divided into 10 groups based on their total asset rank as of 1997. Since the group should be exogenous, the grouping is fixed through out the whole sample period based on the total asset rank as of 1997.

Table 7 provides the estimates of linear model with conglomerates (chaeboles) as reference group with undifferenced data. With least squared estimation, the coefficient on group mean is positive but insignificant. Current sales, sales of two years before and liquid asset has positive effect. Current returns, cash flows and sales of a year before have negative effect. The one year lagged group mean is instrumented with two year lagged group mean but the sign of coefficients do not change. There may be a group invariant unobservable which is correlated with investment and other regressors. This unobservable characteristics would produce biased estimates as mentioned in the previous chapter.

As an alternative setting, differenced data is used. This will remove the group invariant unobservables and may produce unbiased estimates. Table 8 provides the estimates with differenced data. Many coefficients changes the sign. Group mean term shows negative coefficient (-0.292 and -0.233). This may indicate that firms just make the opposite decision to the average firms in the same conglomerates. It is very hard to interpret considering that the conglomerates are controlled by the same family. It may indicate the efforts

Table 8: Estimation with Conglomerates as Reference Group: First Differences

	Dependent Variable: $\Delta(I/K)_{it}$			
	LS with differences with intercept		LS with differences without intercept	
	Coefficients	t-value	Coefficients	t-value
$\Delta(\overline{I/K})_{-ig}^{t-1}$	-.2928868	-3.40	-.2336511	-2.81
$\Delta(ROR1)_{it}$	.019608	4.29	.0198427	4.34
$\Delta(CF/K)_{it}$	-.0373606	-1.84	-.037246	-1.83
$\Delta(S/K)_{it}$	.0642523	9.02	.0635914	8.92
$\Delta(S/K)_{it-1}$	-.0018941	-0.38	-.0029043	-0.59
$\Delta(S/K)_{it-2}$	.0218379	4.34	.0211867	4.22
$\Delta(LQ/K)_{it}$	.0403348	3.78	.0403775	3.78
intercept	.0206539	2.52	-	-

of conglomerates to diversify the investment within its family as a mean of reducing risk in investment.

Table 9 uses generalized method of moments estimation with an instrumental variable(GMM-IV) and Keane and Runkle's two step two stage least squared regression (KR-2SLS). The coefficient for the group mean is respectively (0.238) and (0.081) with each method. It is still positive but has very low significance, or insignificant especially with KR-2SLS. As we see, the estimated coefficient for group mean is not robust, and gets insignificant when we correct the problem with the serial correlation. Therefore, we may say that the effect of copying others investment decision is not clear when we use the conglomerates as reference group.

With this in mind, dummy variables for each year are tried. Table 10 provides the results with year dummies. With year dummies, the coefficients for group effect in each year turns out to be insignificant both with undifference and differenced data. The firm characteristics show significant effects on investment except for the one period lagged total sales.

Conglomerates are possessed by a family but this results show that each firm in the conglomerates may have some autonomy. Usually members firms in a conglomerate are diverse in its product. A car maker may not refer to a chemical manufacturer's investment decision, even though they share same

Table 9: Estimation with Conglomerates as Reference Group: GMM-IV and KR-2SLS:

	Dependent Variable: $(I/K)_{it}$			
	GMM-IV		KR-2SLS	
	Coefficients	z-value	Coefficients	t-value
$(\overline{I/K})^{t-1}_{-ig}$	.2383709	2.37	.0816145	0.62
$(ROR1)_{it}$	-.0267677	-2.43	-.0113268	-1.18
$(CF/K)_{it}$	-.1127065	-1.92	-.1744237	-5.98
$(S/K)_{it}$	.0442279	1.97	.0441307	5.22
$(S/K)_{it-1}$	-.0082112	-0.45	.0041086	0.50
$(S/K)_{it-2}$	.0138354	1.06	.0040965	0.54
$(LQ/K)_{it}$	.1416749	6.40	.1287252	15.15
intercept	.0223518	0.36	.1373548	1.72

"chaebol" logo sign.

5.3 Ex-post Rationality

Wong (2000)'s model explains that all firms' increased optimism may hurt the firms if the bad state is realized. The next specification tries to estimate the ex post results of this simultaneous optimism in Korean firms' investment decision.

Let $(Y/K)_{it}$ be the current profit relative to fixed asset of a firm i at time t. All other variables are defined as in the previous chapters. Group g is the industry which a firm belongs to. As firms follow closely the others, deviation, $[(\overline{I/K})^{t-1}_{-ig} - (I/K)_{it}]$ is going to be smaller. If all firms' simultaneously increased optimism were successful, δ_1 would be negative and significant.

$$(Y/K)_{it} = \alpha_{it} + \delta_1[(\overline{I/K})^{t-1}_{-ig} - (I/K)_{it}] + \varepsilon_{it} \quad (14)$$

The regression result is provided in Table 11. In a pooled regression without year dummies, estimated δ_1 is negative but very small in size (-0.048). The smaller the deviation, the bigger the current profit. With year dummies for intercept and coefficients, estimated δ_1 is positive and insignificant in most of the years. It is significant and positive in 1993 (0.182) and in 1997 (0.164). This may mean that the smaller the deviation, the smaller the

Table 10: Estimation with Conglomerates as Reference Group: Dummies for Each Year

Dependent Variable:	$(I/K)_{it}$		$\Delta(I/K)_{it}$	
	LS		LS with Differences	
	Coefficients	t-value	Coefficients	t-value
$(\overline{I/K})_{-ig}^{t-1}$	-.3733453	-0.83	.4817611	0.76
1992	(dropped)		(dropped)	
1993	.0263213	0.04	-.7438352	-0.85
1994	.3979829	0.66	-.5428885	-0.67
1995	.2009534	0.35	(dropped)	
1996	.5943679	1.14	-.2443251	-0.35
1997	.4410244	0.90	-.4881085	-0.69
1998	.2252537	0.46	-.6018382	-0.73
1999	.4550505	0.90	-.2185142	-0.32
2000	.1949302	0.41	-.4463992	-0.64
$(ROR1)_{it}$	-.0285771	-4.05	.0186542	4.09
$(CF/K)_{it}$	-.1064667	-4.83	-.0409864	-2.02
$(S/K)_{it}$	.0449902	6.85	.0646528	9.10
$(S/K)_{it-1}$	-.0048824	-0.70	-.002939	-0.59
$(S/K)_{it-2}$	.0112929	2.02	.0178938	3.54
$(LQ/K)_{it}$	.1411572	19.84	.0358771	3.36
intercept	.2365467	1.77	.1407104	3.55
1992	.0189632	0.08	(dropped)	
1993	.0178433	0.08	-.1249734	-2.50
1994	-.1776487	-0.74	-.1404844	-3.09
1995	-.0187256	-0.08	-.0906112	-1.95
1996	-.169444	-0.83	-.0864052	-1.77
1997	-.0716755	-0.39	-.1002801	-2.00
1998	.0099967	0.05	-.2100315	-3.91
1999	(dropped)		(dropped)	
2000	.0700213	0.41	-.2461344	-4.46

Table 11: Ex post Rationality

Dependent Variable:	$(Y/K)_{it}$			
	LS		LS with year dummies	
	Coefficients	t-value	Coefficients	t-value
Deviation	-.0489815	-3.68	-.1251949	-2.06
1992			.1551922	1.86
1993			.182789	2.30
1994			.0840749	0.99
1995			.0919057	1.15
1996			.0295601	0.38
1997			.164344	2.30
1998			.0981683	1.36
1999			.0950852	1.41
2000			.0270811	0.40
intercept	.0528166	5.71	.0847784	2.92
1991			.0624376	1.52
1992			.0406398	0.99
1993			.0287624	0.70
1994			.0487872	1.19
1995			.0468995	1.14
1996			(dropped)	
1997			-.0949734	-2.32
1998			-.2891198	-6.98
1999			-.0911042	-2.23
2000			-.0591176	-1.41

current profit. Following other firms decision might hurt the firm itself in those years.

In summary, just copying other firm's optimism might not helpful for firm's profit. Pooled regression shows that it was helpful to follow others, but it was not according to the regression with year dummies. In years around Crisis, the data shows that following others brings less returns. It maybe because the bad state is realized as opposed to increased optimism.

6 Concluding Remarks

This paper studies the behavior in the Korean firm's investment decision before and after the 1997 economic crisis using firm level data. The results show that we may suspect that Korean firms had a tendency to simply follow other firms' capital investment decision. Furthermore, this tendency was aggressive and significant around the crisis in 1997 and was less aggressive or insignificant in other periods.

Firms seemed to follow other firms in the same industry, but they did not seem to follow others in the same conglomerate. Linear model with conglomerates as reference group provides negative or no effects from group. Conglomerates are under a family's ownership but they consist of heterogeneous firms. They also may have certain degrees of autonomy in management.

Dependence in industry' mean level investment itself did not seem to be helpful ex post. Yearly results show the imitating others in the same industry seemed to hurt a firm's current profit in some years around the crisis as bad states might have realized.

The evidence of link between the firm level investment and that of industry may be interpreted as a weak evidence of herding behavior of firms investment. It is weak in a sense that herding is basically psychological phenomenon which is very hard to observe and measure. It is weak in the other sense that the firm level investment's dependence in that of industry may also be interpreted as a form of externality. Overall, the results of study tells us the importance of micro level perspective in looking at the crisis. Around the crisis firms seemed to follow simply others investment decision who produced similar product. This tendency did not seem to helpful to firm's profit ex post. Even though, we see the growth in aggregated data, it may not show the firms' dependence in other firms, and may not be sufficient to explain the crisis. Of course, there were many other factors that might have brought

the crisis in Korea in 1997. We cannot deny the existing all other factors of crisis. Rather, this work tries to provide the one possibility and evidence especially from the micro economic level.

Appendix

We now show the signs of the three effects in (11). Consider first the direct effect. Rewriting (4), we get

$$\begin{aligned}\rho\left(\frac{\partial \pi_i^g}{\partial x_i}\right) + (1-\rho)\left(\frac{\partial \pi_i^b}{\partial x_i}\right) \\ &= \rho[MR^g - w\beta(1+r)] + (1-\rho)[MR^b - w\beta(1+r)] \\ &= 0.\end{aligned}$$

By assumption, $MR^g > MR^b$, implying that $\partial \pi_i^g/\partial x_i > 0 > \partial \pi_i^b/\partial x_i$. By (8), $dx_i/d\rho > 0$. As for the cross effect, $\partial \pi_i^g/\partial x_k < 0$, and $dx_k/d\rho > 0$, assuming all firms are symmetric. As for the foreign-firm effect, $\partial \pi_i^g/\partial x^* < 0$, and $dx^*/d\rho > 0$.

We now turn to the signs of the three effects in (12). First, for the direct effect, note that $\partial \pi_i^b/\partial x_i < 0$, and $dx_i/d\rho > 0$. For the cross effect, note that $\partial \pi_i^b/\partial x_k < 0$ and $dx_k/d\rho > 0$. For the foreign-firm effect, we have $\partial \pi_i^b/\partial x^* < 0$ and $dx^*/d\rho < 0$.

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